Question	Answer	Marks	Guidance
1	$(4k)^2 - 4k(3k+1)$	**M1**	For use of the discriminant to obtain a two term quadratic expression.
	$4k^2 - 4k = 0$	**M1**	Dep to find critical values, allow if only one is found
	$k = 0,\ k = 1$	**A1**	For both critical values
	$k < 0 \quad k > 1$	**A1**	
2(a)	$x^2\left(3e^{3x}\right) + 2xe^{3x}$	**3**	**M1** for differentiation of a product **A1** for $x^2\left(3e^{3x}\right)$ **A1** for $+2xe^{3x}$
2(b)(i)	$2x\left(3x^2+4\right)^{-\frac{2}{3}}$	**2**	**M1** for $kx\left(3x^2+4\right)^{-\frac{2}{3}}$
2(b)(ii)	$\left[\frac{1}{2}\left(3x^2+4\right)^{\frac{1}{3}}\right]_0^2$	**M1**	For $k\left(3x^2+4\right)^{\frac{1}{3}}$
	$\left[\frac{1}{2}\left(16^{\frac{1}{3}}\right) - \frac{1}{2}\left(4^{\frac{1}{3}}\right)\right]$	**M1**	**Dep** for correct substitution of limits into *their* integral
	0.466	**A1**	
3	$\left(\cot^2\theta + 1\right) + 2\cot^2\theta = 2\cot\theta + 9$	**B1**	For use of correct identity
	$(3\cot\theta + 4)(\cot\theta - 2) = 0$ $\cot\theta = -\frac{4}{3},\ \ \cot\theta = 2$	**M1**	For attempt to solve *their* quadratic in $\cot\theta$ to obtain $\cot\theta = k$
	$\tan\theta = -\frac{3}{4},\quad \tan\theta = \frac{1}{2}$	**M1**	For dealing with $\cot\theta = k$ correctly to get $\tan\theta = \frac{1}{k}$
	$\theta = -0.644$	**A1**	
	$\theta = 0.464$	**A1**	
4(a)	$64 - 48x^2 + 15x^4$	**3**	**B1** for 64 **B1** for $-48x^2$ **B1** for $15x^4$

Question	Answer	Marks	Guidance
4(b)	$9-\frac{6}{x^2}+\frac{1}{x^4}$	**B1**	
	$(their 64\times 9)+(their -48\times -6)+(their 15)$	**M1**	For considering terms independent of x, must have 3 terms
	879	**A1**	
5	$e^y = mx^2 + c$	**B1**	May be implied by later work
	$10 = 4.74m + c$ $5 = 2.24m + c$	**M1**	For at least one correct equation
	$5 = 2.5m$	**M1**	Dep for attempt to solve for m
	$m = 2,\ \ c = 0.52$	**A1**	For both
	$y = \ln\left(2x^2 + 0.52\right)$	**A1**	
	Alternative $e^y = mx^2 + c$	**(B1)**	May be implied by later work
	Gradient = $m = \frac{10-5}{4.74-2.24}$	**(M1)**	
	$10 = 4.74(their\ m) + c$ or $5 = 2.24(their\ m) + c$	**(M1)**	
	$m = 2,\ \ c = 0.52$	**(A1)**	For both
	$y = \ln\left(2x^2 + 0.52\right)$	**(A1)**	
6(a)	$\frac{\pi}{3}$	**B1**	
6(b)	$\frac{\pi a}{3}+4a$	**2**	**B2 FT** for $\left(their\frac{\pi}{3}\times a\right)+4a$ or **B1 FT** for $their\frac{\pi}{3}\times a$

Question	Answer	Marks	Guidance
6(c)	$\frac{1}{2}(2a)^2 \sin\frac{\pi}{3}$	**B1**	**FT** *their* $\frac{\pi}{3}$
	$\frac{1}{2}a^2\frac{\pi}{3}$	**B1**	**FT** *their* $\frac{\pi}{3}$
	$\sqrt{3}a^2 - \frac{\pi a^2}{6}$	**B1**	**FT** *their* $\frac{\pi}{3}$
7(a)(i)	${}^8C_4$	**M1**	For realisation that there are 4 places left and 8 people available to fill them
	70	**A1**	
7(a)(ii)	1 teacher on committee: 5 ways	**B1**	
	${}^{12}C_8 - 5$	**M1**	
	490	**A1**	
	Alternative 2 teachers: 70 3 teachers: 210 4 teachers: 175 5 teachers: 35	**(2)**	**B1** for 2 correct cases
	490	**(B1)**	
7(b)	$\frac{n!}{(n-5)!} = 6\frac{(n-1)!}{(n-1-4)!}$	**B1**	
	$\frac{n}{(n-5)!} = \frac{6}{(n-5)!}$	**M1**	For simplification of either $n!$ and $(n-1)!$ or 'cancelling out' of the terms of $(n-5)!$
	$n = 6$	**A1**	nfww
8(a)	$b = 2$	**B1**	
	At $(0, 3)$: $3 = a + c$	**B1**	
	At $\left(\frac{5\pi}{6}, 0\right)$: $0 = a\cos\frac{5\pi}{3} + c$ $0 = \frac{a}{2} + c$	**M1**	For use of *their b* and $\left(\frac{5\pi}{6}, 0\right)$
	$a = 6$ $c = -3$	**A1**	For both

Question	Answer	Marks	Guidance
8(b)	$\left(\frac{\pi}{6}, 0\right)$	**B1**	Allow for $x = \frac{\pi}{6}$
8(c)	$\left(\frac{\pi}{2}, -9\right)$	**2**	**B1** for $\frac{\pi}{2}$ **B1** for -9
9(a)	$y = x^3 - 2x^2 - 4x + 8$	**B1**	
	$\frac{dy}{dx} = 3x^2 - 4x - 4$ $(3x+2)(x-2) = 0$	**M1**	For attempt to differentiate, allow one slip and for equating *their* $\frac{dy}{dx}$ to zero and attempt to solve to obtain $x = k$
	$\left(-\frac{2}{3}, \frac{256}{27}\right)$	**A1**	
	$(2, 0)$	**A1**	
9(b)		**4**	**B1** for curve with maximum in the second quadrant **B1** for $y = 8$ either on the curve or stated **B1** for $x = \pm 2$ either on the curve or stated **B1** for a cusp at $x = -2$ and a min at $x = 2$
9(c)	$0 < k < \frac{256}{27}$	**2**	**FT** on *their* $\frac{256}{27}$ **B1** for either $0 < k$ or $k < \frac{256}{27}$
10(a)	$\overrightarrow{CD} = \frac{3}{4}\mathbf{a}$	**B1**	
	$\overrightarrow{OD} = \mathbf{c} + \frac{3}{4}\mathbf{a}$	**B1**	
	$\overrightarrow{OE} = h\left(\mathbf{c} + \frac{3}{4}\mathbf{a}\right)$	**B1**	
	$\overrightarrow{DE} = h\left(\mathbf{c} + \frac{3}{4}\mathbf{a}\right) - \left(\mathbf{c} + \frac{3}{4}\mathbf{a}\right)$ oe cao	**B1**	
10(b)	$\overrightarrow{DE} = \frac{1}{4}\mathbf{a} + k\mathbf{c}$	**B1**	

Question	Answer	Marks	Guidance
10(c)	$\mathbf{c}(h-1)+\mathbf{a}\left(\frac{3h}{4}+\frac{3}{4}\right)=\frac{1}{4}\mathbf{a}+k\mathbf{c}$	**M1**	For equating *their* answer to (a) to *their* answer to (b)
	$\mathbf{c}(h-1)+\mathbf{a}\left(\frac{3h}{4}+\frac{3}{4}\right)=\frac{1}{4}\mathbf{a}+k\mathbf{c}$ $h-1=k$	**M1**	For attempt to equate like vectors once.
	$h=\frac{4}{3}$	**A1**	
	$k=\frac{1}{3}$	**A1**	
11(a)	$x+2y=10$ $x+y=2$	**M1**	For attempt to solve simultaneously
	$(-6, 8)$	**A1**	
	$x+2y=10$ $x+y=-2$	**M1**	For attempt to solve simultaneously
	$(-14, 12)$	**A1**	
	Alternative $x^2+x(10-x)+\frac{(10-x)^2}{4}=4$ or $(10-2y)^2+2y(10-2y)+y^2=4$	**(M1)**	For attempt to eliminate one of the variables using $(x+y)^2=4$
	$x^2+20x+84=0$ or $y^2-20y+96=0$	**(M1)**	**Dep** for attempt to obtain a 3 term quadratic equation = 0 and solve to obtain at least one solution, allow 1 arithmetic error
	$(-14, 12)$	**(A1)**	
	$(-6, 8)$	**(A1)**	
	Mid-point of AB: $(-10, 10)$	**M1**	For attempt to obtain the mid-point using *their* coordinates for A and B.
	Gradient of line perpendicular to $AB = 2$	**M1**	For attempt to obtain the perpendicular gradient using *their* coordinates for A and B.
	$y-\textit{their}\ 10=\textit{their}\ 2(x-\textit{their}(-10))$	**M1**	
	$20-10=2(-5+10)$ oe	**A1**	For verification

Question	Answer	Marks	Guidance
11(b)	$(10, 50)$	**2**	**FT** on t*heir* midpoint **B1** for each coordinate
	$(-20, -10)$	**2**	**FT** on t*heir* midpoint **B1** for each coordinate